MEMPHIS INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT PROJECT

QUARTERLY AND
ANNUAL PROGRESS REPORT
(Deliverable #10)

September 19, 1977 - December 31, 1977

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MASTER

MEMPHIS LIGHT, GAS & WATER DIVISION

P.O. Box 430

MEMPHIS, TENNESSEE 38101

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY OF FOSSIL ENERGY

UNDER CONTRACT DE-AC02-77ET13406
(FORMERLY CONTRACT ET-77-C-01-2582)

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MEMPHIS LIGHT, GAS AND WATER DIVISION

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COMMISSIONER
MRS. PATRICIA W. SHAW
COMMISSIONER
JACK H. MORRIS
COMMISSIONER

January 30, 1978
Letter No. ME-6F

Department of Energy
400 First Street, N.W.
Mail Station 504
Washington, D.C. 20545

Attention: Mr. Frederick Zito

Subject: MLGW Reference No. 8802
DOE Reference No. 2582
TASK XI - QUARTERLY AND
ANNUAL REPORTS

Gentlemen:

Attached are 25 copies of the Quarterly Technical Status Report covering the period 19 September 1977 through 31 December 1977.

Since our entire effort for the year was included in this reporting period, we intend this report to suffice as our Annual Report also.

Very truly yours,

R W Gray/eg
R. W. Gray
MLGW Program Manager

RWG/RJS/fd
Attachment

CC: William Stevenson ✓
Department of Energy

RECEIVED
1978 FEB -2 AM 9 46
PROCUREMENT DIVISION

Industrial Low BTU Fuel Gas Demonstration Plant Program (Phase I)

Quarterly and Annual Report

**For
The Department of Energy
Under Contract EF-77-C-01-2582**

19 September 1977 - 31 December 1977

**MEMPHIS LIGHT, GAS AND WATER DIVISION
In Association with
FOSTER WHEELER ENERGY CORPORATION
INSTITUTE OF GAS TECHNOLOGY
DELTA REFINING COMPANY**

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1.0 Contract Objective and Scope of Work

The objective of the Industrial Low BTU Gas Demonstration Plant Program is to demonstrate the feasibility of converting coal to fuel gas and utilizing this gas in a commercial application. Specific objectives of this program are to conduct process analysis, design, construction, testing, operation, and evaluation of a plant based on the U-GAS process for converting coal to fuel gas.

Phase I of the program is for the Program Development and Conceptual Design of the Demonstration Plant. Also included in Phase I is a conceptual design of a Commercial Plant.

2.0 Summary of Progress to Date

Work during the period September 19, 1977 (start of work) and December 31, 1977 was concentrated into the following tasks:

Task I - Conceptual Design and Evaluation of Commercial Plant
Task IV - Site Evaluation and Selection
Task V - Demonstration Plant Environmental Analysis
Task IX - Technical Support
Task XI - Program Management

The current (as of December 31, 1977) progress of work is shown on the Milestone Plan and Management Report included as Appendix A. In essence, the program is on schedule.

3.0 Detailed Description of Technical Progress

Task I - Conceptual Design and Evaluation of Commercial Plant

The Commercial Plant gasifier heat balances, material balances, and utility requirements have been prepared based on Kentucky No. 9 coal. The work associated with Task I during the reporting period is concentrated in two areas. First, a preparation of the on-site heat and material balances for the plant and second, studies and evaluations of alternate process schemes.

The work on the heat and material balances commenced on December 5, 1977 on receipt of the IGT gasifier balance. There was a small revision to this balance (about 3%) which was corrected on January 3, 1978. Based upon this information, Foster Wheeler is proceeding with the heat and material balances required for the on-site process. This work is approximately 50% complete and is scheduled for completion on March 4, 1978. (Note: Overall heat and material balances including off-sites and utility is scheduled for completion March 26, 1978.

The steady activity is proceeding on a tradeoff between sulfur removal and sulfur plant alternatives. The alternatives being investigated are as follows:

Base Case: Selexol, Claus, SCOT, Incinerator
Alternative 1: Selexol, Claus, Beavon
Alternative 2: Selexol, Sulfuric Acid
Alternative 3: Benfield, Stretford, Product Gas Drying

Work is proceeding on these studies to develop capital and operating costs for these alternatives.

A general process description of the Commercial Plant is shown as Appendix B. This process description includes the Base Case sulfur removal and sulfur plant alternative.

Task IV - Site Evaluation and Selection

Delta Refining Company is conducting a preliminary site survey with the objective of identifying major problems associated with the delivery of equipment for construction at the proposed site.

Task V - Environmental Analysis

Draft work statements for the required environmental analysis were completed and reviewed with appropriate DOE personnel. After this review, which was conducted at Foster Wheeler on December 19, 1977, a revised draft was prepared and again sent to DOE for comment.

Foster Wheeler's objective is to engage a qualified subcontractor so that data-collecting in the field can begin in February 1978. To achieve this objective, Foster Wheeler has, as part of its contract with MLGW, included for the services of an environmental subcontractor namely, Westinghouse Environmental Systems Division (now known as Energy Impact Associates). Foster Wheeler has requested DOE to approve its award of a subcontract to Energy Impact Associates. DOE has requested substantiation of this request which Foster Wheeler agreed to provide early in January.

Task IX - Technical Support

A Plan of Interfacing Schedule and Test Work for Pilot Plant was prepared and submitted to DOE. The plan outlines the interface arrangements between the two DOE programs that require the use of the ash-agglomerating gasifier (AAG) pilot-plant facilities. The two DOE programs are: 1) Operation of the Atmospheric Ash-Agglomerating Gasifier on Coal Contract No. EX-76-C-01-2336; and 2) Industrial Low BTU Fuel Gas Demonstration Plant, Contract No. EF-77-C-01-2582. The plan also describes

the schedule of operations and test work for the period of time that AAG pilot plant is available for use by the Demonstration Plant Program. A contingency plan showing the impact on the overall schedule if a pretreatment step is required to feed the Western Kentucky No. 9 coal into the gasifier is being prepared. Preliminary engineering and addition of a pretreatment reactor to the AAG pilot plant is underway. Most of the major equipment required for pressure modification of the AAG has been ordered: delivery dates of this equipment at present appear compatible with the schedule for modification of the AAG pilot plant. A questionnaire has been prepared to be sent out to potential MIGW fuel gas customers soliciting information on their combustion system and gas usage patterns to proceed with analysis of utilization characteristics of the fuel gas from the Demonstration Plant.

Task XI - Program Management

The Cost and Manpower Plans were submitted to DOE December 21, 1977. The Milestone Plan and Management Report was submitted on January 10, 1978. All sub-contractors (FWEC, IGT, and DRC) continued to work under letter subcontractor during the period. DOE provided consent to FWEC's definitized subcontract to MIGW on December 16, 1977. Contract execution was not accomplished during this period, however, and a further letter extension for two weeks was issued to FWEC. (Note: All subcontracts were executed at MIGW on January 11, 1978.)

4.0 Conclusions

A major problem which arose during the reporting period was that of the completion of the required environmental analysis in order not to impact Phase II of the program. This problem was addressed and a proposed solution was agreed to in January. A sole source procurement justification for Energy Impact Associates was prepared and submitted to DOE for approval. This sole source procurement will enable construction start as scheduled (8 months after start of Phase II) whereas a competitive procurement would have delayed that start by 6 months and with an additional inflationary cost to the program in excess of \$5,000,000.

The work on the Commercial Plant is proceeding essentially on schedule. No major problems are foreseen on the Commercial Plant design. A major problem to be faced in 1978 is the achievement of successful operating data from the pilot plant necessary to confirm a demonstration plant design. This data must be obtained at 3 atmospheres of pressure and requires additional modifications to the existing plant as described in IGT's Interface Plan submitted in January.

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT MANAGEMENT SUMMARY REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant		2. Reporting Period 11/30 through 12/31/77		3. Contract Number EF-77-C-01-2582											
4. Contractor (name and address) Memphis Light Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101		5. Contract Start Date September 19, 1977*		6. Contract Completion Date May 19, 1979											
7. Months		O	N	D	J	F	M	A	M	J	J	A	S	8. FY 1978	
9. Cost Status															
a. Dollars (Thousands)	7,000													e. Actual Costs Prior FYs	
	6,000													2	
	5,000													f. Planned Costs Prior FYs	
	4,000													2	
	3,000													g. Total Estimated Accrued Costs for Contract	
	2,000													172	
	1,000													h. Total Contract Value	
Accrued Costs		b. Planned	7	54	112	362	421	476	511	560	535	350	363	373	\$6,460,316
		c. Actual	7	54	111										Phase I
		d. Variance			1										
10. Manpower Status															
a. Manhours (Hundreds)	2,000													e. Actual Manpower Prior FYs	
	1,000													2	
	800													f. Planned Manpower Prior FYs	
	600													2	
	400													g. Total Estimated Manpower for Contract	
	200													755	
Manpower		b. Planned	3	18	37	108	121	125	140	149	146	114	114	115	h. Total Contract Manpower (hours)
		c. Actual	3	18	32										194,700
		d. Variance			5										
11. Major Milestone Status															
a.	Task I														
b.	Task 1-1														
c.	Task V													May 19, 1979	
d.	Task V-1														
e.	Task IX													May 19, 1979	
f.	Task IX-1														
g.	Task XI													May 19, 1979	
h.															
i.															
12. Remarks *Subcontractor start dates October 24 and November 11, 1977.															
13. Signature of Contractor's Project Manager and Date <i>RW Gray</i> 1-12-78										14. Signature of Government Technical Representative and Date					

CONTRACT MANAGEMENT SUMMARY REPORT

PURPOSE

A single-page graphic presentation of integrated cost, manpower, and major milestones for rapid visual analysis and trend forecasting.

INSTRUCTIONS

- Item 1 – Enter the contract/agreement identification as it appears in the official document establishing the contract or agreement.
- Item 2 – Enter the inclusive start and completion dates for the reporting period for this report.
- Item 3 – Enter the contract/agreement number as it appears in the official establishing document.
- Item 4 – Enter the name and address of the contractor, organization, or agency, as they appear in the contract/agreement.
- Item 5 – Enter the official start date of the original contract/agreement.
- Item 6 – Enter the official completion date, as of the latest official modification to the contract/agreement.
- Item 7 – In the extreme left of the 12 blocks, enter the first letter of the current fiscal year month in which contract work is performed. Enter successive months of the current fiscal year, as required.
- Item 8 – Enter current fiscal year.
- Item 9 – a – Enter an appropriate scale in dollars for the horizontal lines in the grid and indicate unit of measure (e.g., thousands, millions, etc.). On the grid formed by the dollar scale and the months of the year, plot planned cumulative cost (using a dashed line) for the current fiscal year and actual cumulative cost (using a solid line) for each month up to and including the month being reported, with a dotted line extended from that point to indicate estimate of costs to be incurred for the remainder of the fiscal year.
- b – Enter total planned dollar cost for each month of the current fiscal year.
- c – Enter total actual dollar cost for each month of the current fiscal year up to and including the month being reported.
- d – Subtract the planned cost (9b) from the actual cost (9c) for each month up to and including the month being reported and enter the difference. Show minus amounts in parentheses. Flag actual on projected variance by placing the symbol ⊗ in the right hand margin opposite this item.
- e – Enter total actual costs for all prior fiscal years (see latest approved Cost Plan, Item 9).
- f – Enter total planned costs for all prior fiscal years (see latest approved Cost Plan, Item 8).
- g – Enter the current estimate of total accrued costs required to complete contract (see Cost Management Report, Item 18c).
- h – Enter total negotiated contract cost (see Cost Management Report, Item 19).
- i – Enter total Obligation Ceiling Line at top of the graphical representation. The total obligation ceiling is the total funds obligated by the government plus the contractor's cost share. When applicable, reflect changes in obligation ceiling without changing prior ceiling line.
- Item 10 – a – Enter an appropriate scale in manpower for horizontal lines in grid and indicate unit of measure (e.g., manhours, manmonths, etc.). On the grid formed by the manpower scale and the months of the year, plot planned cumulative manpower (using a dashed line) for the current fiscal year and the actual cumulative manpower (using a solid line) for each month up to and including the month being reported, with a dotted line extended from that point to indicate estimate of manpower to be expended for the remainder of the fiscal year.
- b – Enter total planned manpower for each month of the current fiscal year.
- c – Enter total actual manpower for each month of the current fiscal year up to and including the month being reported. Flag actual on projected variance by placing the symbol ⊗ in the right hand margin opposite this item.
- d – Subtract the planned manpower (10b) from the actual manpower (10c) and enter the difference. Show minus amounts in parentheses. Flag actual on projected variance by placing the symbol ⊗ in the right hand margin opposite this item.
- e – Enter total actual manpower for all prior years (see latest approved Manpower Plan, Item 9).
- f – Enter total planned manpower for all prior fiscal years (see latest approved Manpower Plan, Item 8).
- g – Enter current estimate of total manpower required to complete contract (see Manpower Management Report, Item 18c).
- h – Enter total negotiated contract manpower (see Manpower Management Report, Item 19).
- i – Enter the total Manpower Ceiling Line at top of the graphical representation. The total manpower ceiling is the total manpower funded by the government plus the contractor's share when applicable. Reflect changes in manpower ceiling line without changing prior ceiling line reported.
- Item 11 – a through i – Enter current fiscal year event identifiers as established in contract. In the horizontal space to the right of each event, plot milestone and activity data by month using the charting information shown in instructions for the Milestone Plan and Management Report. If event is not scheduled for completion in the current fiscal year, enter in the space at the extreme right the planned month and year of completion prefixed with "C" (e.g., C7-80). Flag any schedule variance by placing the symbol ⊗ in the right hand margin opposite the appropriate line.
- Item 12 – Enter any explanatory remarks. Items flagged by the symbol ⊗ must be explained fully in this space, on an attached sheet, or in the Technical Status Report.
- Item 13 – Signature of responsible contractor, agency, or organization project manager and date signed, stating the reasonableness of the information furnished based upon his personal knowledge of the contractor's progress and status.
- Item 14 – Signature of responsible ERDA Government Technical Representative and date signed, verifying the reasonableness of the information furnished.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program		2. Reporting Period through		3. Contract Number EF-77-C-01-2582	
4. Contractor (name, address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101		5. Contract Start Date September 19, 1977		6. Contract Completion Date May 19, 1979	

7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months												10. Percent Complete											
		F.Y. 1978																							
Task		O	N	D	J	F	M	A	M	J	J	A	S	F.Y. 1979											
														O	N	D	J	F	M	A	M	J	J	A	
I	Comm Plt Des and Eval																								
I - 1	Process Eng Des																								
I - 2	Risk Analysis																								
I - 3	Proj Eng Des																								
I - 4	Cost Est																								
I - 5	Econ/Env. Impact																								
I - 6	Demo Plt Proc Recomm.																								
II	Demo Plt Proc Des																								
II - 1	Basis of Design																								
II - 2	Proc. Eng Design																								
II - 3	Proc Desc. and Rationale																								
III	Demo Plt Process and Mech Design Pkg																								
III-1	Prelim Eng and Layouts																								
III-2	Plant Specifications																								

11. Remarks	

12. Signature of Contractor's Project Manager and Date <i>R W Gray</i> 1-12-78	13. Signature of Government Technical Representative and Date
---	---

APPENDIX B

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program		2. Reporting Period through		3. Contract Number EF-77-C-01-2582	
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7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months F.Y. 1978												F.Y. 1979												10. Percent Complete
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A		
III-3	Cost Est																									
III-4	Proc. Eng Rpt.																									
III-5	Failure Analysis																									
III-6	Procurement Req																									
IV	Site Eval/Selection																									
IV-1	Site Data																									
IV-2	Site Agreement																									
V	Env. Analysis																									
V-1	Basis for Env. Analysis																									
V-2	Proj. Desc. for Env. Anal.																									
V-3	Demo Plt Environment																									
V-4	Proj. Opn																									
V-5	Mitigation Measures																									
V-6	Adverse Env. Effects																									

11. Remarks

12. Signature of Contractor's Project Manager and Date
R. W. Gray / RGH 1-12-78

13. Signature of Government Technical Representative and Date

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

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7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months												10. Percent Complete
Task		<div style="display: flex; justify-content: space-between;"> <div>F Y 1978</div> <div>F Y 1979</div> </div> <div style="display: flex; justify-content: space-between;"> <div>O N D J F M A M J J A S</div> <div>O N D J F M A M J J A</div> </div>												
V-7	Long Term Aspects													
V-8	Irreversible Commitments													
V-9	Alternatives													
V-10	Env. Report													
VI	Materials and Licenses													
VI-1	Coal/Water Plans													
VI-2	Prod. Disposition													
VI-3	Prop. Licenses													
VI-4	Const Codes/Ord													
VI-5	Permits/Licenses-Plan													
VII	Const/OPN Planning													
VII-1	Conf. Mgt Plan													
VII-2	Staffing Plan													
VII-3	Safety													
11. Remarks														
12. Signature of Contractor's Project Manager and Date <i>R W Gray</i> 1-12-78						13. Signature of Government Technical Representative and Date								

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

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7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months		10. Percent Complete	
Task		<div style="display: flex; justify-content: space-between;"> <div>F Y 1978</div> <div>F Y 1979</div> </div> <div style="display: flex; justify-content: space-between;"> <div>O N D J F M A M J J A S</div> <div>O N D J F M A M J J A</div> </div>			
VII-4	Procurement Plan				
VII-5	Sched/Controls				
VII-6	Labor Surveys				
VII-7	Summary Plans				
VIII	Economic Assessment				
VIII-1	Commercial PLT				
VIII-2	Demo PLT				
IX	Technical Spt				
IX-1	Design Data				
IX-2	Test Opn				
IX-3	Turn down				
IX-4	Start up/Shutdown				
IX-5	Mechanical Config.				
IX-6	Math Model				
11. Remarks					
12. Signature of Contractor's Project Manager and Date R W Gray 1/8/78 1-12-78			13. Signature of Government Technical Representative and Date		

11. Remarks	
12. Signature of Contractor's Project Manager and Date R W Grant 12/12/78	13. Signature of Government Technical Representative and Date

INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT

INTERMEDIATE EVENT LOG

TASK	SUBTASK	SUBTASK DESCRIPTION	INTERMEDIATE EVENTS	SCHEDULED RELEASE	ACTUAL RELEASE
I	I-1	PROCESS ENGR. DESIGN	A- RECEIPT OF ATMOSPHERIC HEAT & MATERIAL BALANCES FROM IGT B- ATMOSPHERIC PRESSURE RUNS (KENTUCKY #9) COMPUTED BY IGT C- HEAT & MATERIAL BALANCES D- PROCESS FLOW DIAGRAMS E- PROCESS DUTY SPECS FOR EQUIPMENT F- PROCESS DESCRIPTION	12/03/77 2/28/78 3/26/78 4/09/78 4/09/78 4/16/78	
II	II-1	BASIS OF DESIGN	A- RECEIPT OF PROCESS HEAT & MATERIAL BALANCES FROM IGT B- PROCUREMENT OF EQUIPMENT BY IGT FOR PRESSURE OPERATION C- CONFIRMING HEAT & MATERIAL BALANCES FROM IGT	5/1/78 5/1/78 6/01/78	
	II-2	PROCESS ENGR. DESIGN	A- HEAT & MATERIAL BALANCES B- PROCESS FLOW DIAGRAMS	7/25/78 7/25/78	
III	III-1	PRELIMINARY ENGR. & LAYOUTS	A- EQUIPMENT LIST B- ENGINEERING FLOW DIAGRAMS C- EQUIPMENT DATA SHEETS D- INSTRUMENT DATA SHEETS	9/20/78 12/26/78 12/26/78 01/03/79	
IX	IX-1	TECHNICAL SUPPORT	A- CONFIRMING HEAT & MATERIAL BALANCES FROM IGT	6/01/78	
	IX-2		A- MODIFICATION FOR PRESSURE TESTING BY IGT	4/30/78	
	IX-7		A- DOE APPROVAL REQ'D FOR PLANS TO OBTAIN EXPERIMENTAL DATA	3/01/78	

APPENDIX C

GENERAL PROCESS DESCRIPTION COMMERCIAL PLANT

The Commercial Plant is designed to process about 2,800 tons per stream day of high-sulfur, caking Western Kentucky bituminous coal to produce 50 billion BTU per day of industrial fuel gas having a gross heating value of about 284 BTU/SCF.

The process offered in this proposal can manufacture industrial fuel gas from all types of coal and lignite. The fuel gas consists mainly of hydrogen and carbon monoxide. A typical analysis is presented below:

<u>Component</u>	<u>Vol%</u>
H ₂	45
CO	36
CH ₄	2
CO ₂	16
N ₂	<u>1</u>
	100

The sulfur content of the industrial fuel gas is sufficiently low (about 70 volume parts per million of H₂S plus COS) so that the flue gas from the combustion operations employed by industrial consumers will meet current stack-gas emission regulations.

The overall process consists of a number of unit processes which are listed below:*

Primary Process Units

- * Coal Handling and Preparation
- * Coal Gasification
- * Gas Cooling
- * Gas Scrubbing
- * Gas Compression
- * Gas Treating
- * Tail Gas Treating

By-Product Process Units

- * Sulfur Recovery

*Note: This description refers to the "Base Case" Process scheme and does not include description of the various alternative schemes being considered as trade-off studies.

Auxiliary Process Units

- * Steam Generation
- * Air Separation
- * Raw Water Treatment
- * Boiler Feedwater Treatment
- * Cooling Water System
- * Waste Water Treatment
- * Ash Handling and Disposal
- * Raw Materials, Chemicals, and By-Products Storage
- * Miscellaneous Facilities

The overall process combines new coal gasification technology and existing, commercially proven technology for all other portions of the plant.

1.1 COAL HANDLING AND PREPARATION

Coal is delivered by barge to an unloading dock adjacent to the plant. Conventional unloading and transfer equipment is employed to move the coal from the barges to the storage area and thence to the coal preparation system. Coal preparation consists of crushing the raw coal to 1/4" x 0. Conventional crushing mills and screens are suitable for this operation. The crushed coal is transferred to storage silos and then transferred, as required, to the Coal Gasification Unit.

1.2 COAL GASIFICATION

The U-GAS reactor system has not been commercialized, but the Demonstration Plant Development Program, now in progress, will provide the technology needed for the commercial unit. The U-GAS reactor operates at about 90 psia. No pretreater is included in the Commercial Plant Design.

The single-stage gasifier comprises in essence a carbon-rich, dense-phase fluidized bed of coal reacting simultaneously with steam and oxygen to produce carbon monoxide, carbon dioxide, and hydrogen. Two reaction zones are maintained within the gasifier with different chemistry, temperature, and functions. The larger reaction zone is a non-slagging, dense-phase, steam-oxygen fluidized bed, where most of the coal is reacted to gaseous products. The smaller zone - the ash-agglomerating zone - at the bottom of the gasifier is maintained at a higher temperature with a superficial gas velocity which is an order of magnitude higher than the velocity in the larger zone. In the turbulent agglomerating zone, ash particles preferentially adhere to other ash particles and grow in the form of spheroidal pellets; when these reach a certain size they can fall out through the bottom injection throat, countercurrent to feed gas flow.

Fines elutriated from the fluidized bed with the raw fuel gas - resulting either from attrition or from the coal crushing operation - are returned to the gasifier through external cyclones. The fines from the external cyclones are recycled to extinction.

The ash agglomerates from the high-temperature zone in the gasifier drop into a water-filled hopper. The hot agglomerates are quenched by a circulating stream of water. The accumulated agglomerates are withdrawn from the hopper in the form of a water slurry and cooled in a heat exchanger. The slurry is then let down in pressure from 75 psig through a special valve.

1.3 GAS COOLING

The hot, raw fuel gas is partially cooled in a waste heat boiler where high-pressure steam is generated for consumption within the Demonstration Plant facilities.

1.4 GAS SCRUBBING

The partially-cooled, raw fuel gas is fed to a venturi scrubber where it is contacted with a circulating aqueous stream. The fuel gas contains ammonia, hydrogen sulfide, and coal dust. The water dissolves most of the ammonia and some hydrogen sulfide. Particulate matter is scrubbed from the fuel gas and reports to the aqueous stream as suspended particles. A dilute slurry is withdrawn from the bottom of the scrubber and sent to the sour water stripper in Section 600, Tail Gas Treating. The raw fuel gas exits the scrubber essentially free of particulates and cooled to about 120°F.

1.5 GAS COMPRESSION

Next the fuel gas is sent to raw gas compression where it is boosted in pressure from about 54 psig to 195 psig. The compressed raw fuel gas is then sent to Section 400, Gas Treating.

1.6 GAS TREATING

The compressed gas is treated in a Selexol acid-gas absorption process to remove essentially all of the hydrogen sulfide and organic sulfur compounds. A portion of the carbon dioxide is also removed from the fuel gas. The Selexol process employs a proprietary solvent as the acid-gas absorbent. The capability of the Selexol process to remove and concentrate hydrogen sulfide and organic sulfur compounds selectively in preference to carbon dioxide is a key feature of the process. Another feature of the Selexol process is the ability to dry the fuel gas adequately so that no additional fuel gas drying process is required before the gas is delivered into the pipeline distribution system. The purified gas from the Selexol unit consists of hydrogen, carbon monoxide, methane, carbon dioxide, and nitrogen.

1.7 SULFUR RECOVERY

Acid gas containing hydrogen sulfide is fed to a conventional Claus process. The off-gas from the Claus unit, substantially free of hydrogen sulfide, is sent to the Tail Gas Treating Unit.

1.8 TAIL GAS TREATING

The off-gas from the Claus unit, together with the gas from a sour water stripper treating sour water from the Gas Treating unit, is processed in a conventional SCOT process. The SCOT process hydrogenates sulfur dioxide and other sulfur compounds to hydrogen sulfide, is recycled to the Claus unit. The off-gas from the SCOT unit is suitable for venting to the atmosphere.

1.9 AIR SEPARATION

The air separation unit provides the coal gasification reaction system with pure oxygen, and also makes available a stream of nitrogen for purging and blanketing purposes.

1.10 AUXILIARY PROCESS UNITS

The auxiliary process units are conventional processes and facilities. The exact configuration and requirements for them will be dictated by the detailed process design to be completed in Phase I.